

CLAIMS

What is claimed is:

- 1 1. An apparatus comprising:
  - 2 a plasma chamber containing a plasma for a plasma-assisted material
  - 3 process upon a substrate;
  - 4 a shielding plate within said plasma chamber to actively direct ion
  - 5 flux to desired areas of the substrate; and
  - 6 a supporting structure to support said shielding plate within said
  - 7 chamber.
- 1 2. The apparatus of claim 1 wherein the plasma-assisted material process is a
- 2 plasma-assisted etching process.
- 1
- 2 3. The apparatus of claim 1 wherein the plasma-assisted material process is a
- 3 plasma-enhanced chemical vapor deposition process.
- 1
- 2 4. The apparatus of claim 1 wherein the shielding plate and the supporting
- 3 structure are composed of a dielectric material.
- 1
- 2 5. The apparatus of claim 1 wherein the supporting structure further comprises
- 3 three or more supporting members.
- 1

2 6. The apparatus of claim 1 wherein the shielding plate is solid to suppress ion  
3 flux at the center of the substrate.

1

2 7. The apparatus of claim 1 wherein the shielding plate has one or more  
3 perforations that allow ion flux to pass, such that the ion flux within a localized area  
4 of the substrate is fitted to meet the requirements of a desired material process.

1

2 8. The apparatus of claim 1 wherein the dimensions of the plate are dependent  
3 upon the dimensions of the plasma chamber and the substrate.

1

2 9. The apparatus of claim 8 wherein the thickness of the plate is 2-5 mm.

1

2 10. The apparatus of claim 1 wherein the distance between a member of said  
3 supporting structure and said substrate is greater than the mean free path of a  
4 reactive particle.

1

2 11. The apparatus of claim 1 wherein the width of a member of said supporting  
3 plate is less than the mean free path of a reactive particle.

1

2 12. The apparatus of claim 1 wherein the edge of said plate is rounded.

1

2 13. The apparatus of claim 1 wherein the plate is circular.

1

2 14. The apparatus of claim 1 wherein the plasma-assisted material process is  
3 carried out in high-density plasma.

1

2 15. A method comprising:

3 optimizing the dimensions, geometry, and location of a shielding  
4 plate to generate a desired ion flux in a plasma-assisted material process  
5 conducted in a plasma chamber;

6 inserting the plate above a substrate in the chamber; and

7 carrying out the desired material process upon the substrate by the  
8 ion flux generated.

1

2 16. The method of claim 15 further comprising optimizing the dimensions,  
3 geometry, and location of the shielding plate by numerical simulation.

1

2 17. The method of claim 16 further comprising performing the optimization  
3 process such that a set of numerically simulated plasma potential contour lines are as  
4 close to parallel to the plane of a simulated substrate surface as possible.

1

2 18. The method of claim 15 further comprising varying localized ion flux across  
3 said substrate by perforating said plate.

1

2 19. The method of claim 14 further comprising optimizing the uniformity of  
3 energy flux across the substrate surface.

1

2 20. A method comprising:

3           actively directing ion flux within a plasma chamber by the insertion  
4           of a plate into the chamber; and

5           regulating ion flux to different areas of the substrate by altering  
6           properties of the plate.

1

2 21. The method of claim 20 further comprising conducting a plasma-assisted  
3 etching process upon the substrate.

1

2 22. The method of claim 20 further comprising conducting a plasma-enhanced  
3 chemical vapor deposition process upon the substrate.

1

2 23. A method comprising:

3           placing a shielding plate within a plasma chamber to actively direct  
4           ion flux, such that the ratio of (neutrons) / (neutrons + ions) bombarding a  
5           substrate is regulated.

1

2 24. The method of claim 23 further comprising controlling the rates of horizontal  
3 and vertical etching upon the substrate.

1

2 25. The method of claim 24 further comprising producing cavities in the  
3 substrate having the desired critical dimensions by the directed ion flux.

1

2 26. The method of claim 25 further comprising customizing the dimensions of  
3 each cavity according to the requirements of a plasma-assisted etching process.

1

2 27. A method comprising:

3                   actively directing ion flux within a plasma chamber by the insertion  
4 of a shielding plate such that the accumulation of etching by-products across  
5 the surface of a substrate is regulated.

1

2 28. The method of claim 27 further comprising improving etch uniformity across  
3 the substrate.

1

2 29. The method of claim 27 further comprising:

3                   preventing the non-uniform accumulation of etching by-products at  
4 the center of a substrate; and  
5                   increasing the etching rate at the center of the substrate.